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A Subsidiary of Elbit Systems

The Power of Vision

30 Years of Infrared Development in Israel

Gabby Sarusi
El-Op, Israel

IR Generation

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Zero Generation

- *Serial scanning single element PC MCT/InSb/PbS/PbSe*

1st Generation

- *Parallel scanning 60, 120 and 180 elem. Linear array PC or PV MCT*

(Common Module Type)

2nd Generation

Long Linear & TDI Arrays:

- *240(256)x2 linear arrays*
- *288x4 (6) TDI PV MCT*
- *480 x 4(6) TDI PV MCT*

2D Arrays

- *320 x 256 up to 640x480 elements InSb &MCT (MWIR)*
- *320 x 256 up to 640x480 elements MCT &QWIP (LWIR)*
- *320x256 up to 640x480 Uncooled microbolometer*

3rd Generation

- *Large format (1Kx1K and up) 2D Array*
- *Smart Pixel:*
  - *Multi-spectral, polarization*
  - *A/D on Chip*
  - *On Chip Local DRC…*

IR Main Players in Israel

	Technion	Soreq NRC	Hebrew Univ.	SCD	El-Op	Rafael	IAI	Controp	Opgal
	R & D Materials and Devices			R & D, Manufacturing Detectors			R & D, Manufacturing Systems Level		
1970	x			x	x	x			
1980	x	x		x	x	x			X
1990	x	x	x	x	x	x	X	X	X
2000	x	x	x	x	x	x	x	X	X

IR Technologies Evolution
(In leading countries)

Category	Applications	1970	2000	2005	2010
High End	•MBT •Fixed wing & Helicopters •Naval Targeting •Air and Ground Reconnaissance	**Zero Gen.** 1 Element 1x8 TDI 1x14 TDI	**1st Gen.** 180x1 120x1 60x1	**2nd Generation** Long Linear TDI 480x4 Large Format FPA 640x480	**3rd Generation** •Very large Format •Smart Pixel •Multispectral Imaging
Medium End	•Man Portable •Missiles Launcher •Surveillance •Security			Mid-format 320x240 2D cooled FPA	•3-5 µm & 8-12 µm •2D FPAs •MCT/InSb(ABC)/QWIP
Low End	•Thermal Weapon Sight •Driving Aid •Hand Held •Goggle type TI •Paramilitary •Disposable Sensors			Uncooled Microbolometers Medium Format	•Uncooled M.B. Large Format •Disposable Thermal Imager •Un-attendant Sensors

The First Decade of IR 1976-1986

100x1 PC InSb

120x1 PC MCT

Single Element or w/wo a TDI

The Trigger

- The Israeli Navy Battleship “Eilat” was drowned by four Egyptian Ship-to-Ship Missiles on October 21st 1967.

- One of the solutions to detect ship-to-ship missiles approaching the ship is by Infrared Search and Track System - IRST. RFP was issued by the Israeli Navy.

IRST System Concept- El-Op

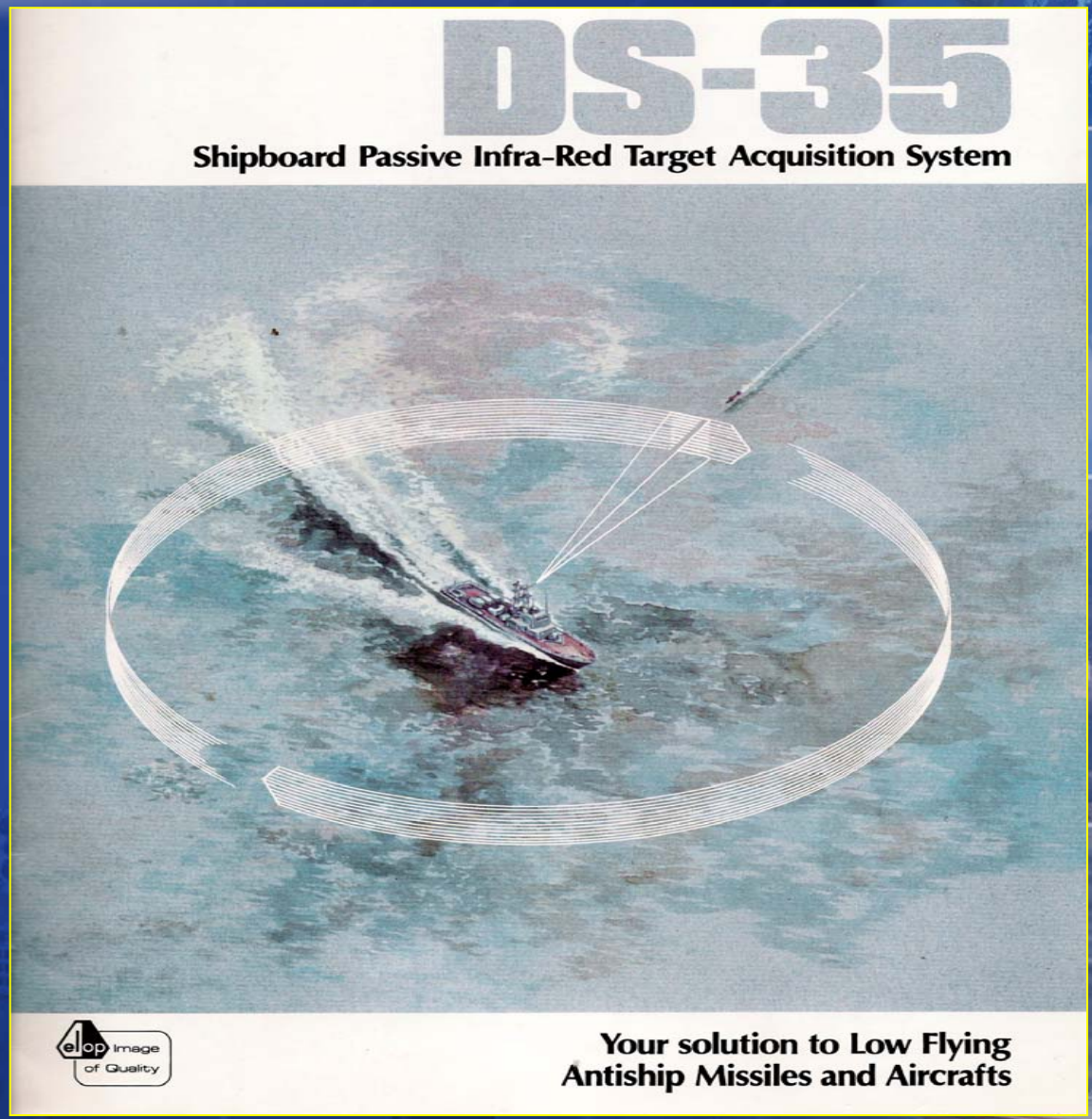
1973: System concept (Bjorn Andresen)
1974: Efforts to Buy a US detectors, 60 elements linear array type.
1974: US government puts a hold on any delivery of sensitive technologies to the middle east.

↓

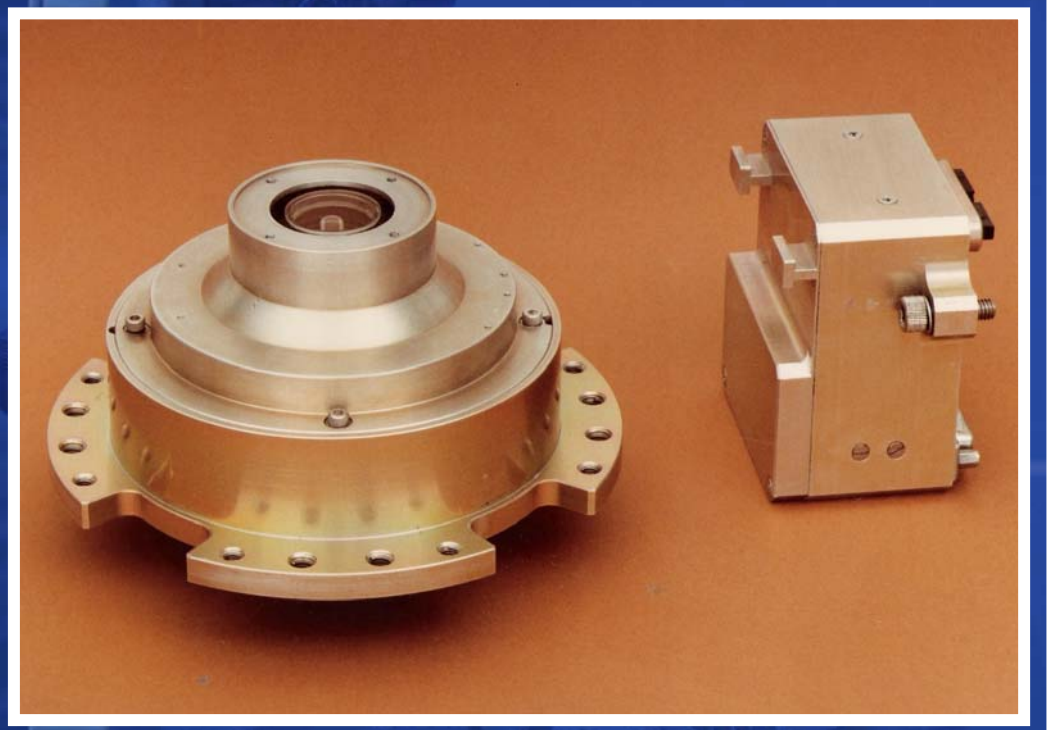
"Nothing sharpen the human mind but the guillotine"

↓

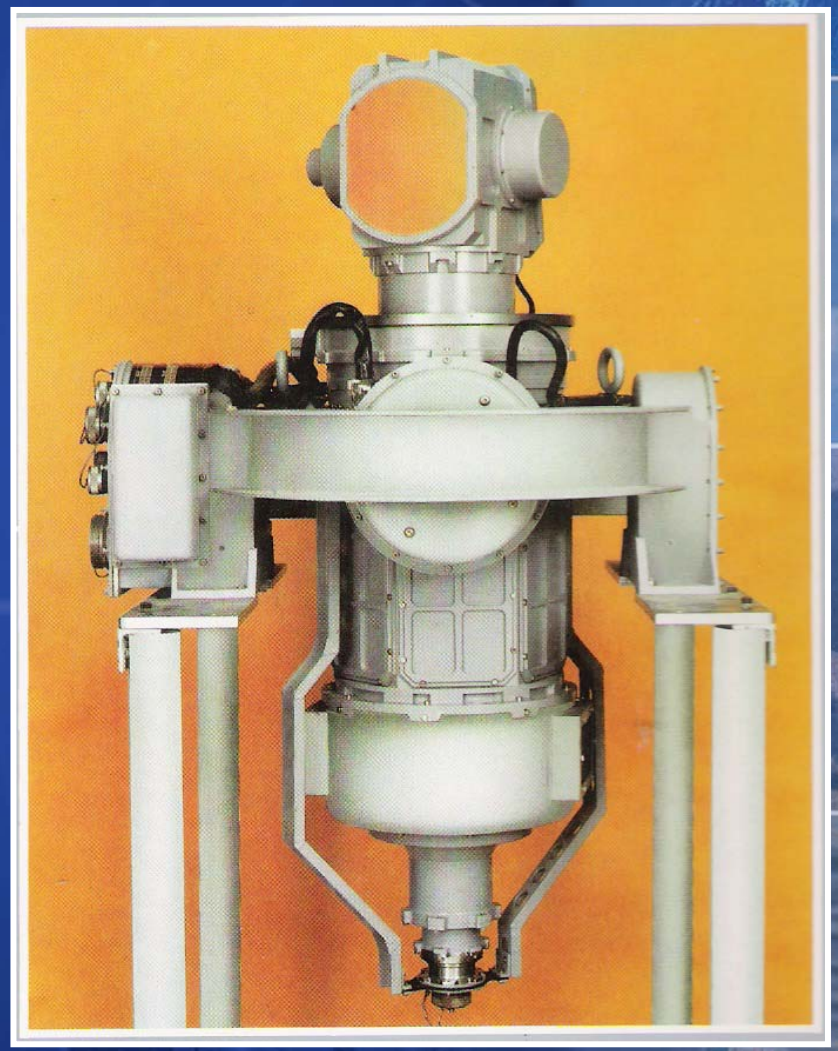
1975:development of Israeli detector at the Technion Labs. By Prof. I. Kidron



El-Op's IRST 1977



Detector 100x1Elements PC InSb
(Prof. I. Kidron, Technion)



Elop's IRST (Bjorn Andresen)

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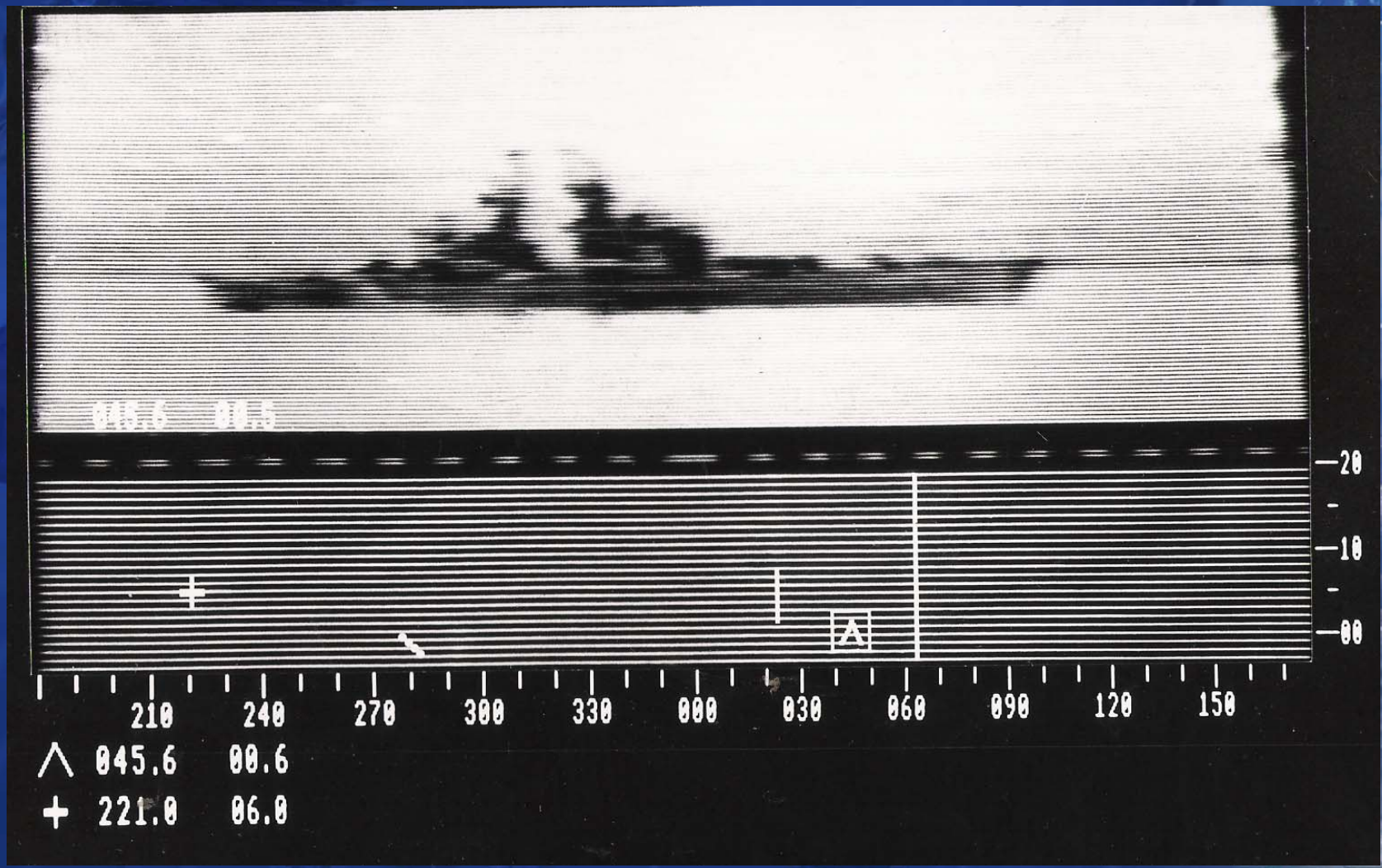
IRST First Image 1977



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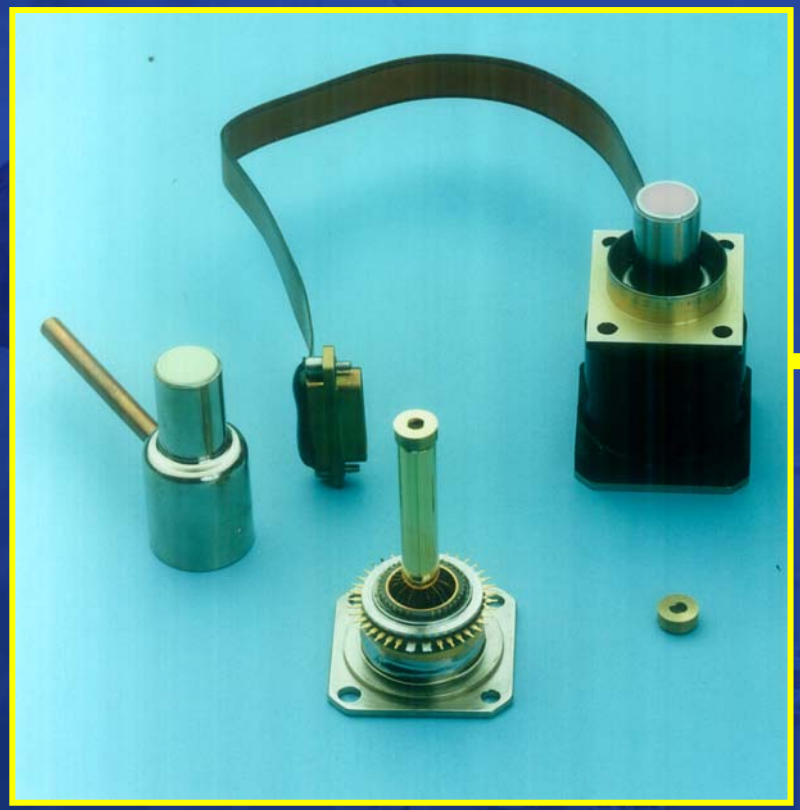
PC-MCT 1x14 TDI for the Gunner sight of Merkava Mk. 1 &2 MBT

(Technology transfer agreement with Honeywell)



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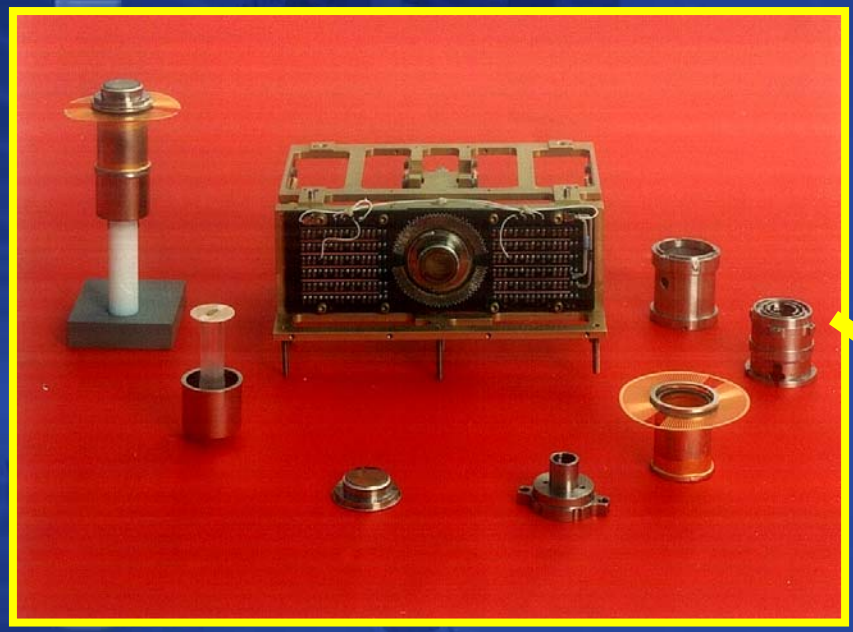
1985

PC-MCT 120



The Second Decade 1986-1996

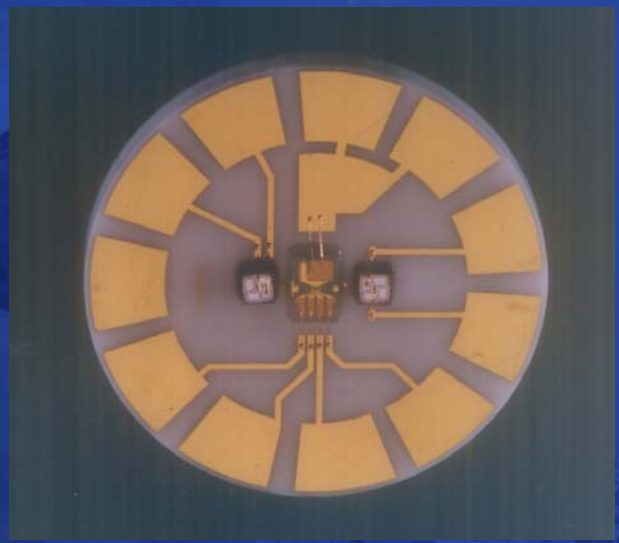
4 Element (Quadrate) - Rafael

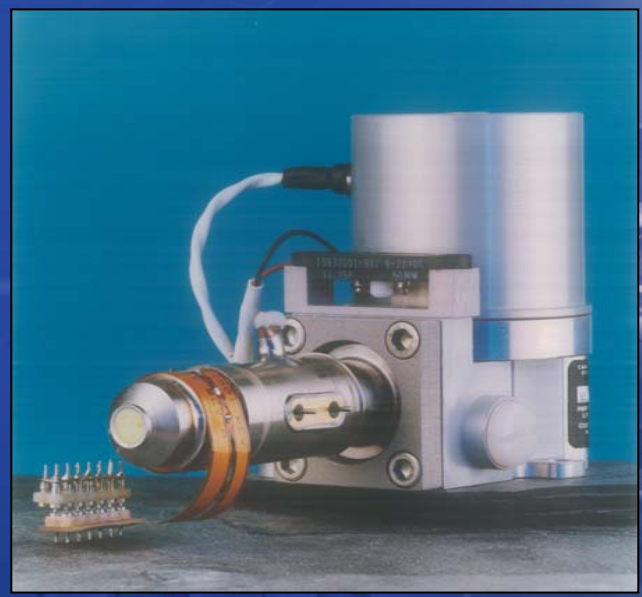
120x1 PC MCT

128x1 PV MCT

1989

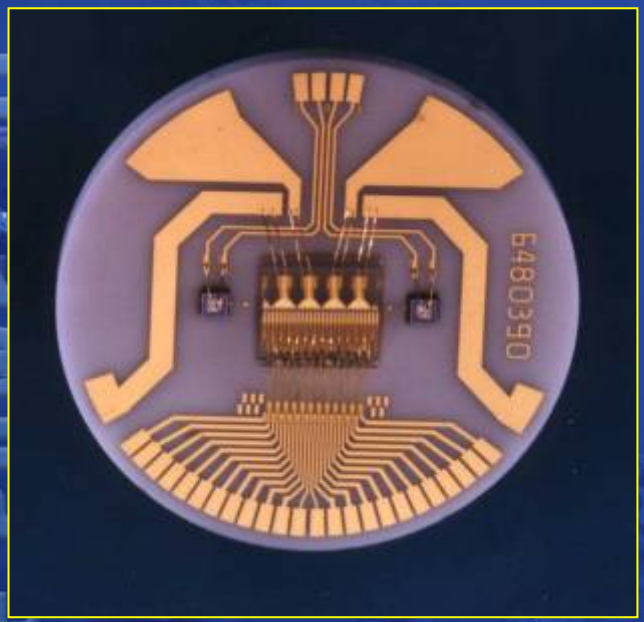
PC-MCT 4 quadrates



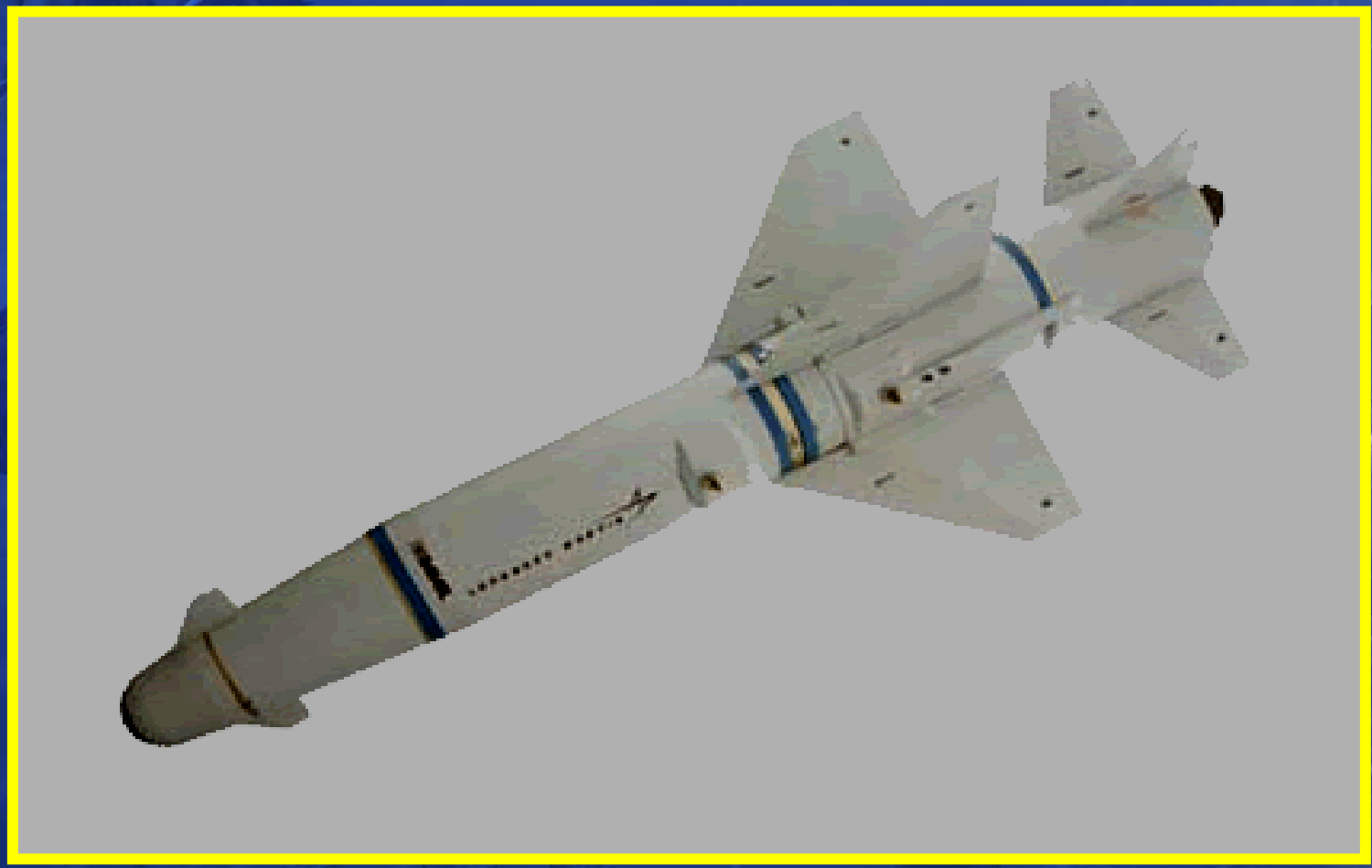


1993

PC-MCT 24

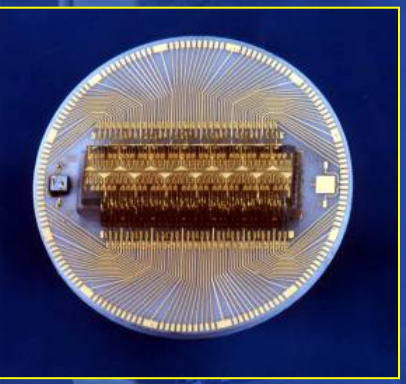


Popeye Rafael's/Lockheed-Martin Air to Surface Missile



PC-MCT 120 Elements

1989



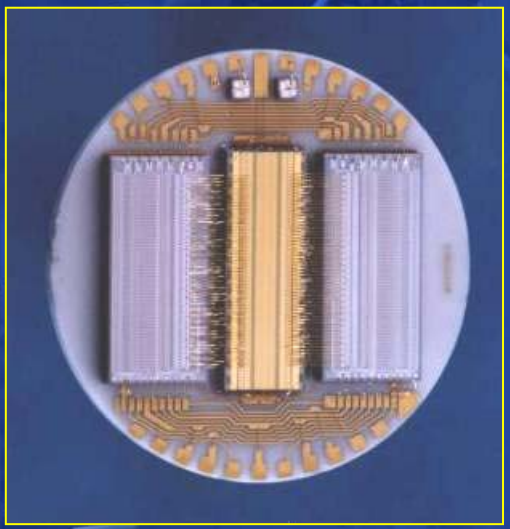
TES, El-Op

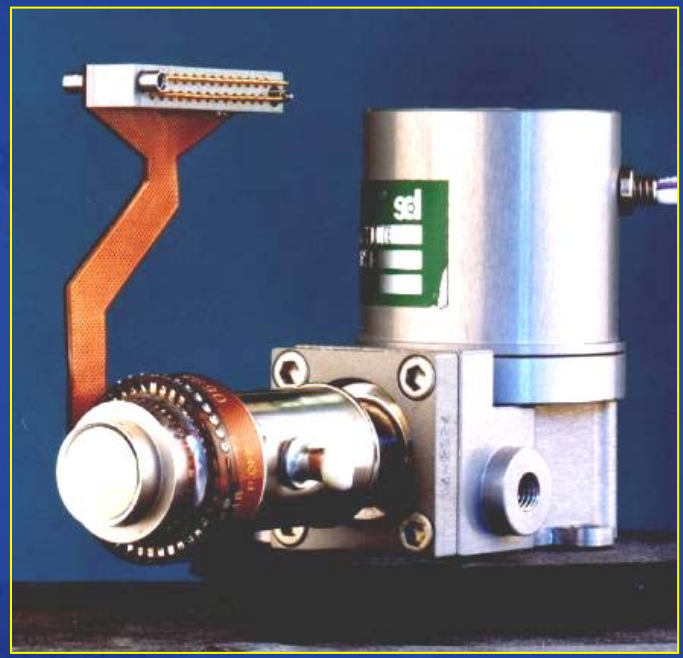
Spice Missile by Rafael

1989

1990

PV-MCT 128





TIM – EI-Op

- First time signal processing in the FPA
- Serial production to the NATO Leopard II Commander sight

The Third Decade 1996-2006

256x2 PV MCT

288x6 PV TDI MCT

480x6 PV TDI MCT

320x256 QWIP

320x256 PV InSb

640x512 PV InSb

2048x? PV TDI InSb

384x288 UC Micro-Bolometer

320x256 QWIP dual band NIR/SWIR-LWIR

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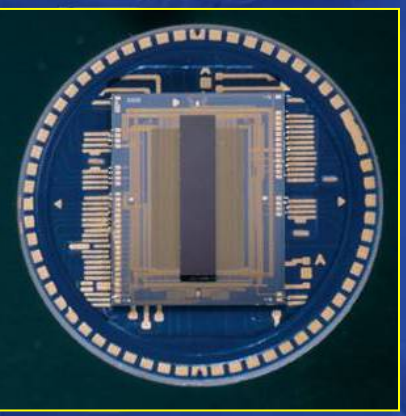
1996

PV-MCT 256x2



HHTI EI-Op

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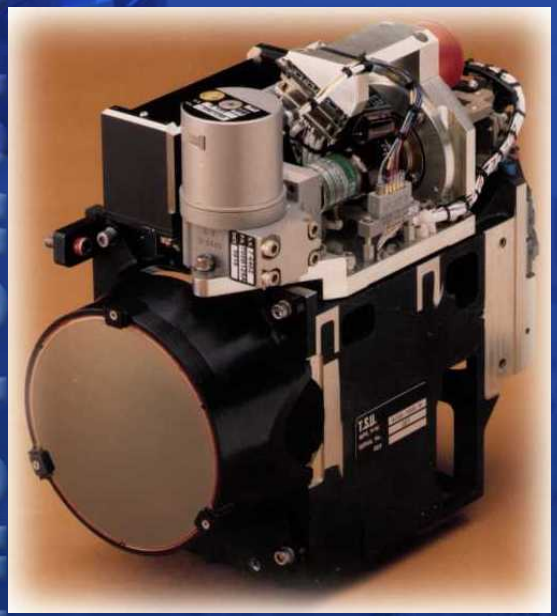
PV MCT 256x2 8-12 µm



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1997

The Big Question!

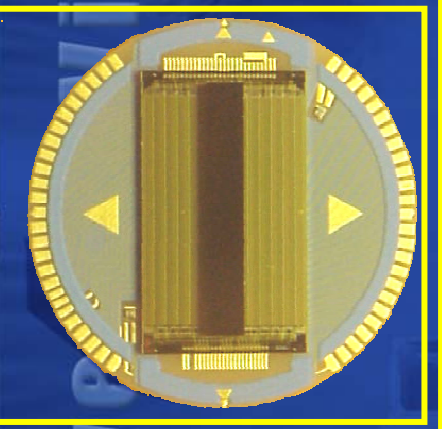
- Will the gunner have 3-5 micron FLIR or 8-12micron FLIR?

At this time the InSb technology start to show great results after multi millions $ of investment at SCD.

Field Test!!! @ the Golan Heights

PV-MCT 480x6 TDI (Elop)

1998-9



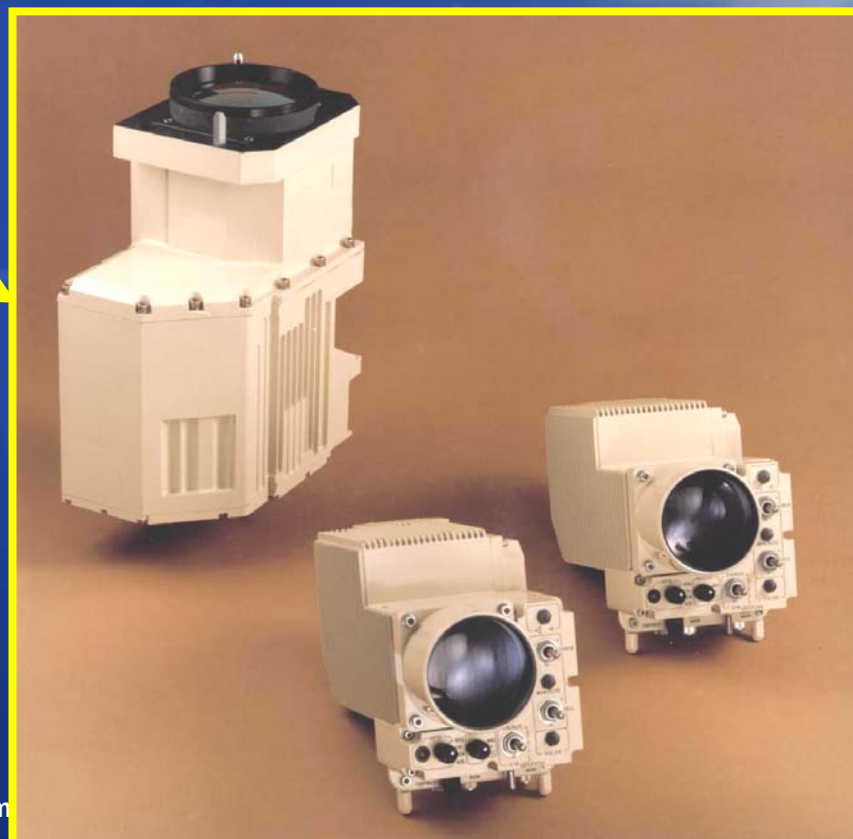
TDI 480x6 HgCdTe (SCD)

Infantry Head / Helmet Mounted Uncooled FLIR 1999 – El-Op (US made detectors)

1999-2000

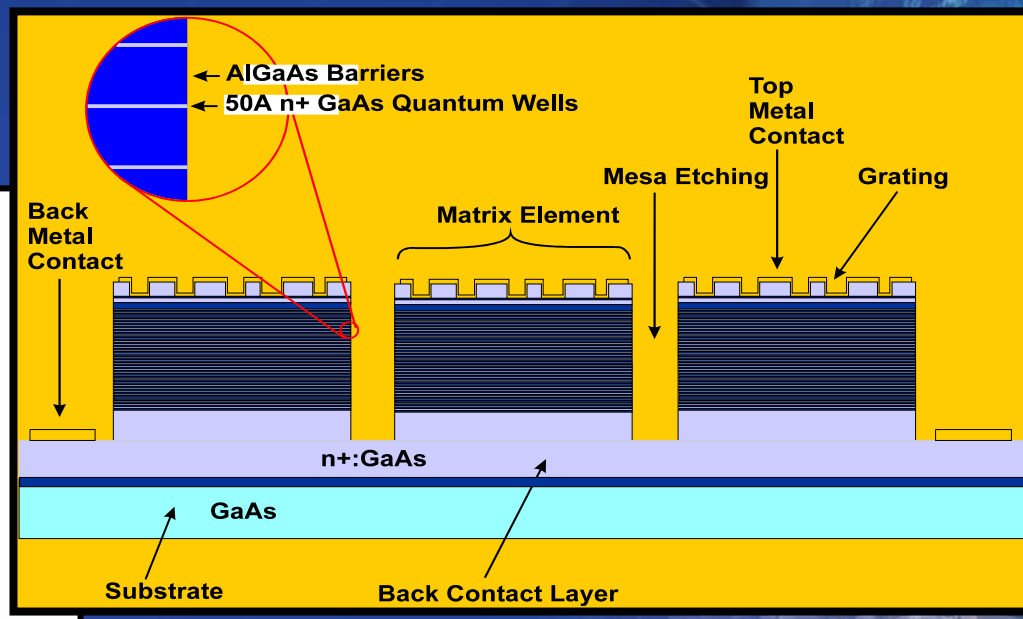
2003

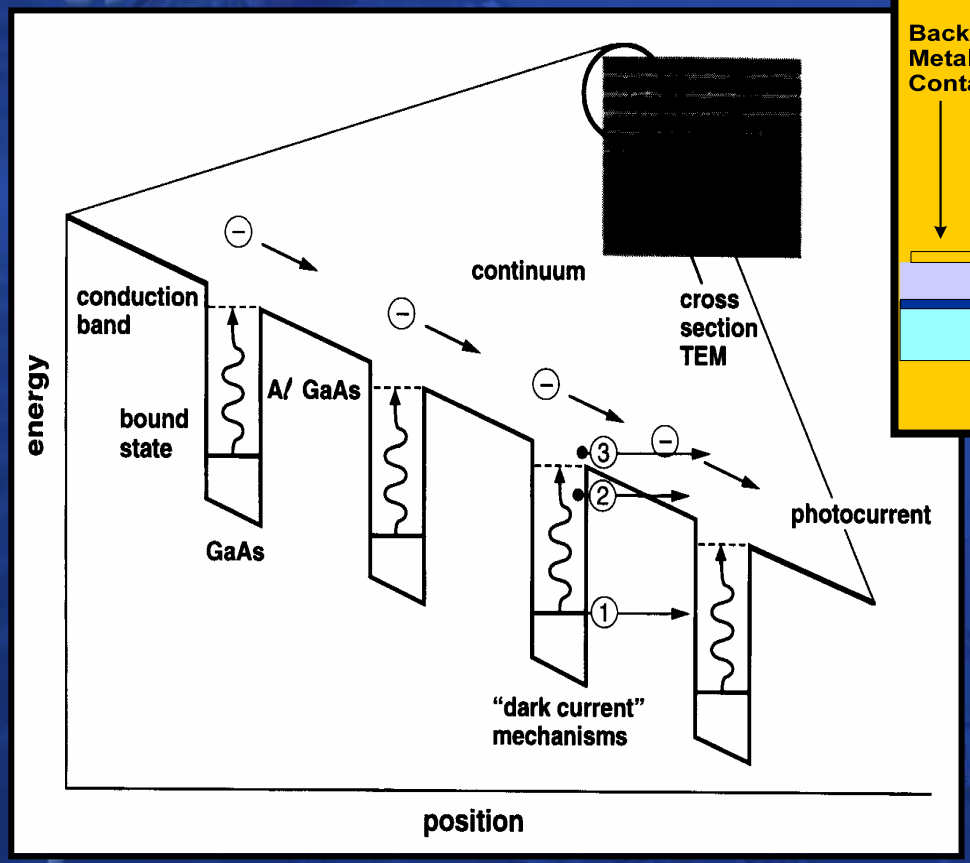
PV-MCT 288x4 TDI (El-Op)

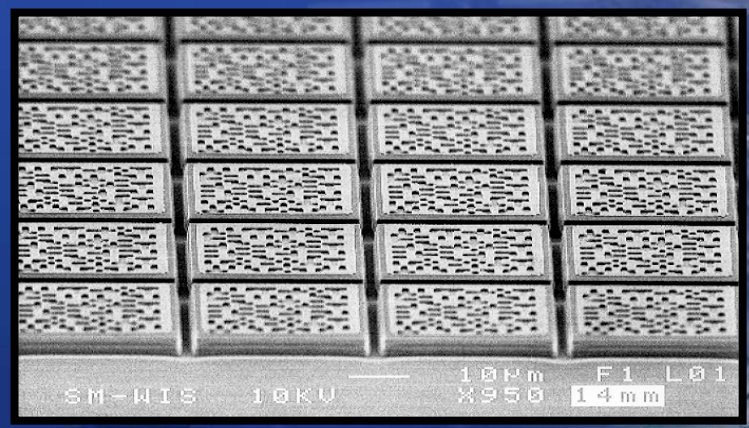


QWIP Activities: 1996-2006 (Technion, Hebrew Univ., ELOP, SCD)

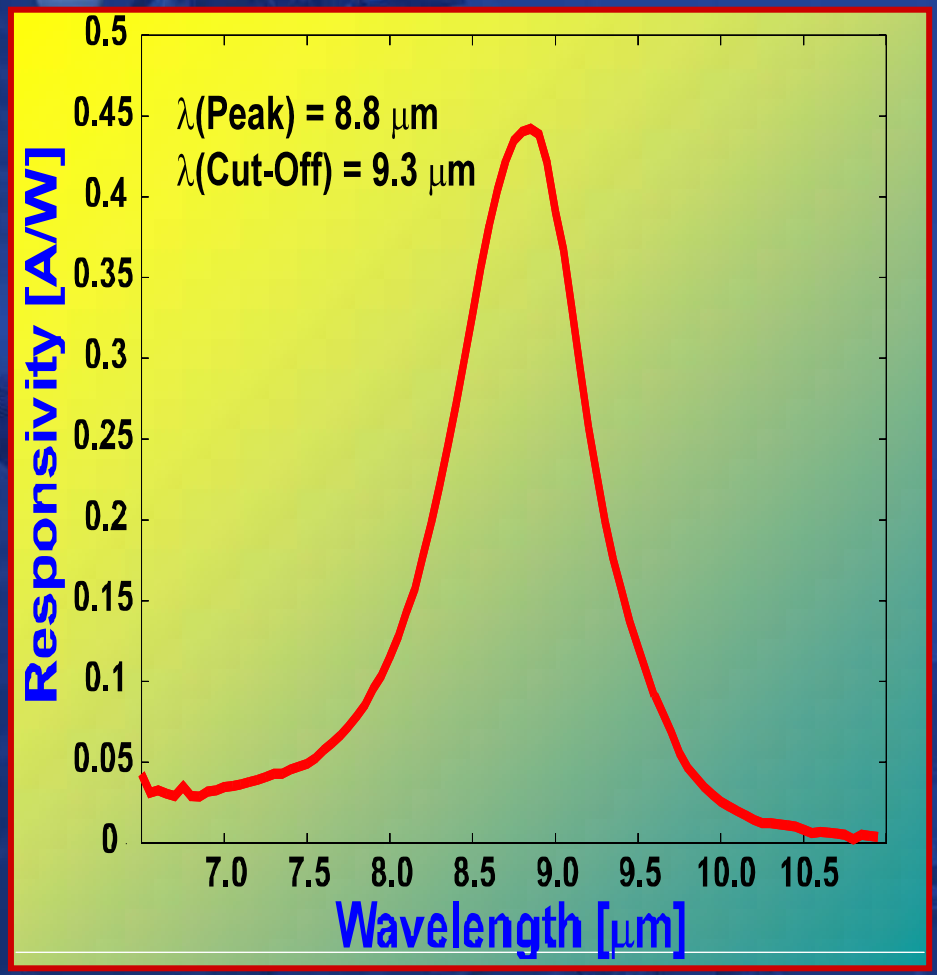
QWIP Basic Structure

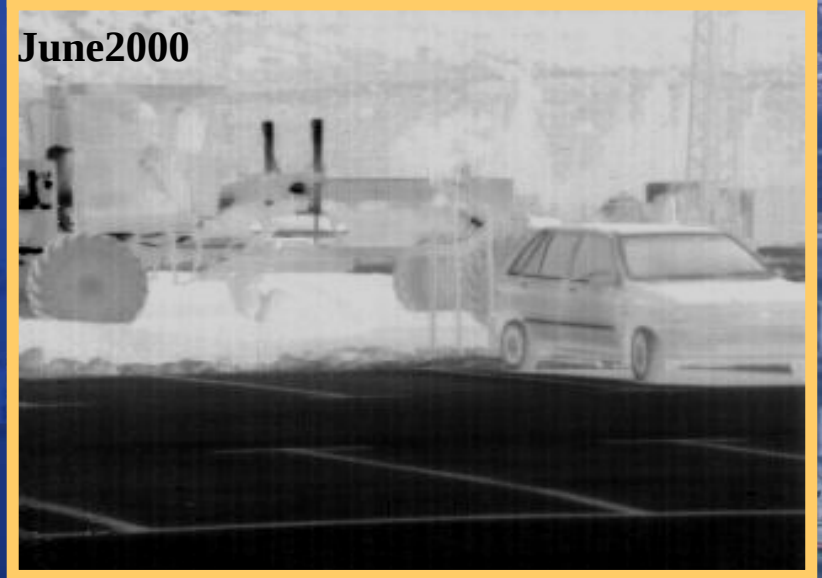






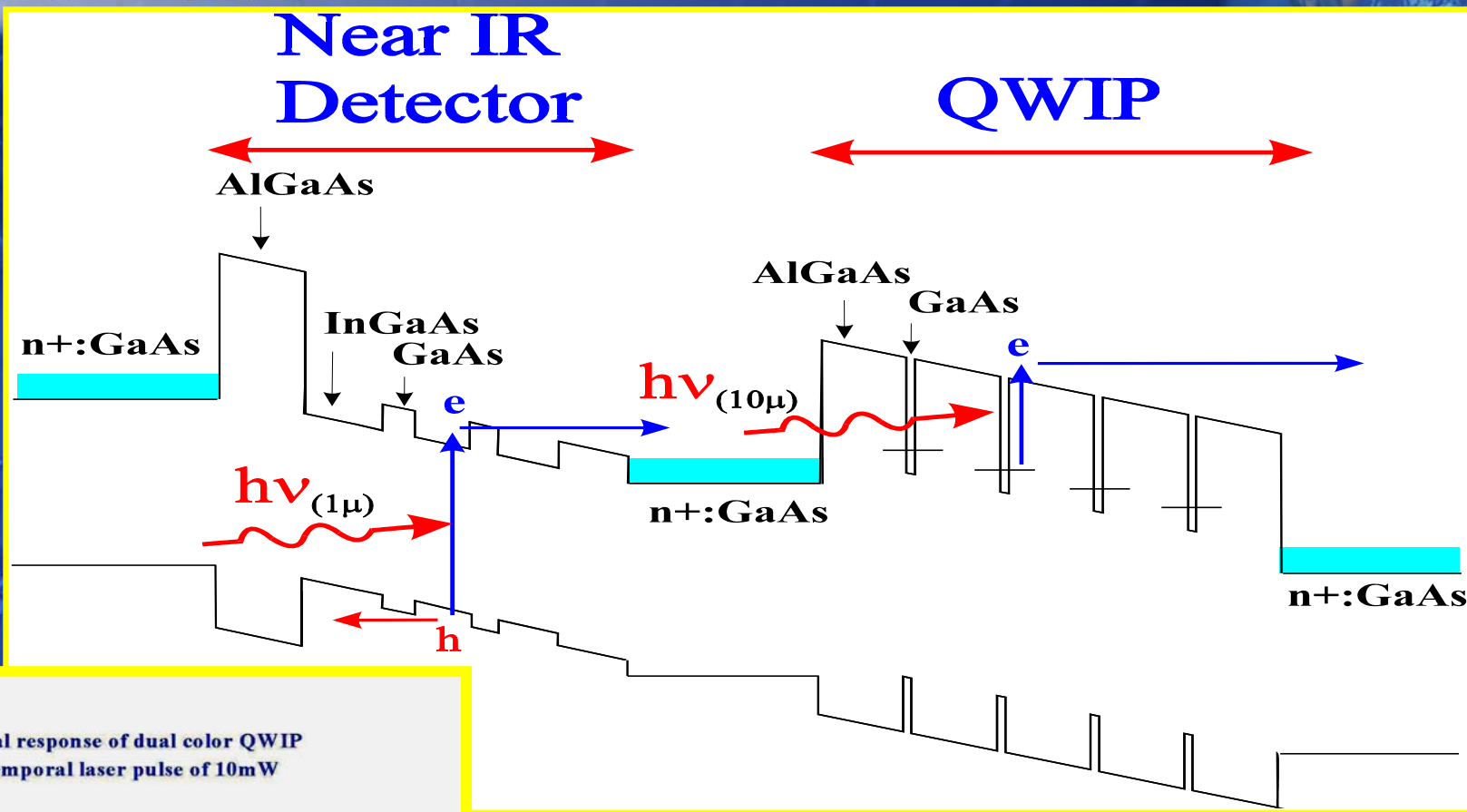
QWIP Spectral Response and Imagery at El-Op

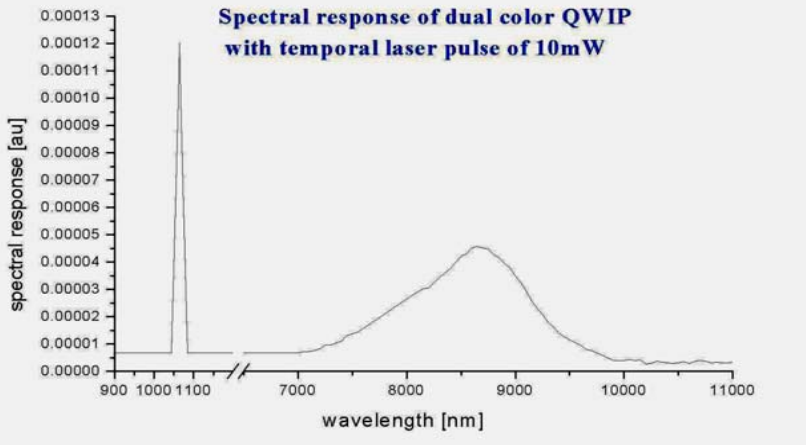




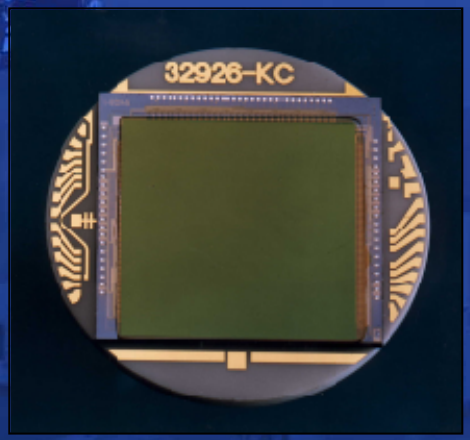
See-Spot QWIP Band diagram (El-Op)

2001





128x128x40µm Jeppetto



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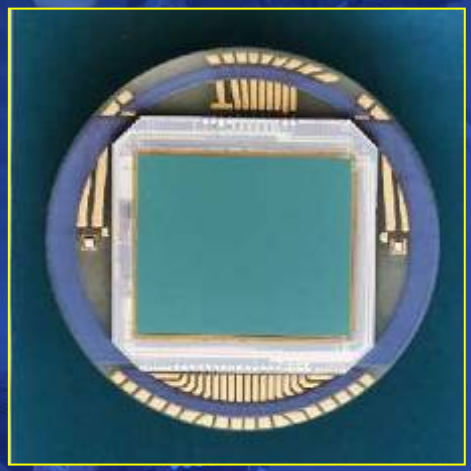
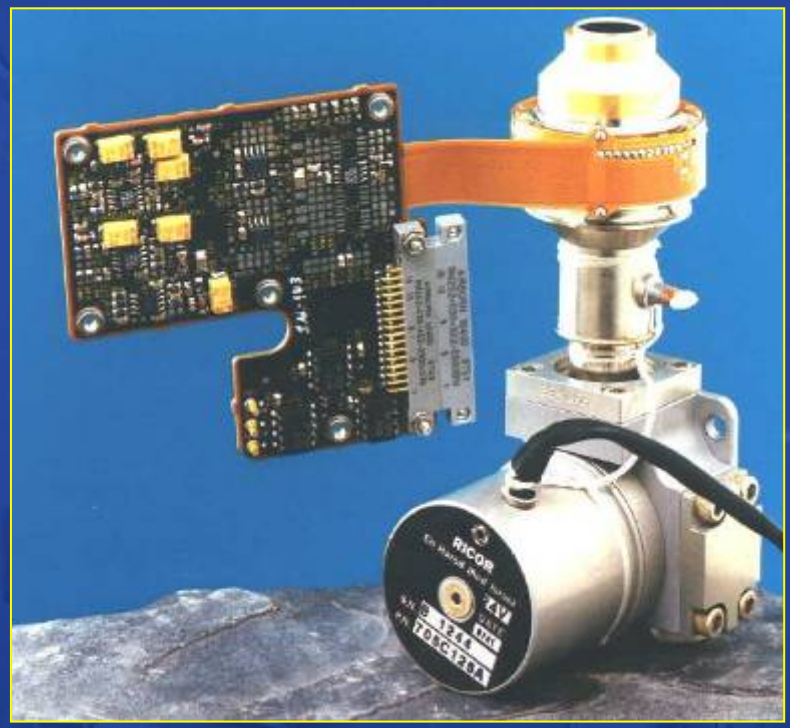
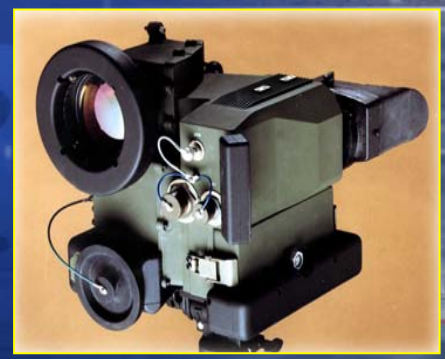
1997

Gemini 320x256x30µm







1998-9

Rafael's "Spike" Anti-Tanks Missile

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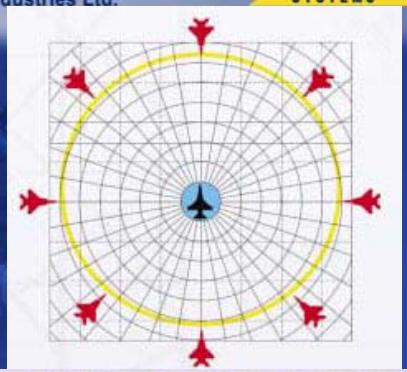
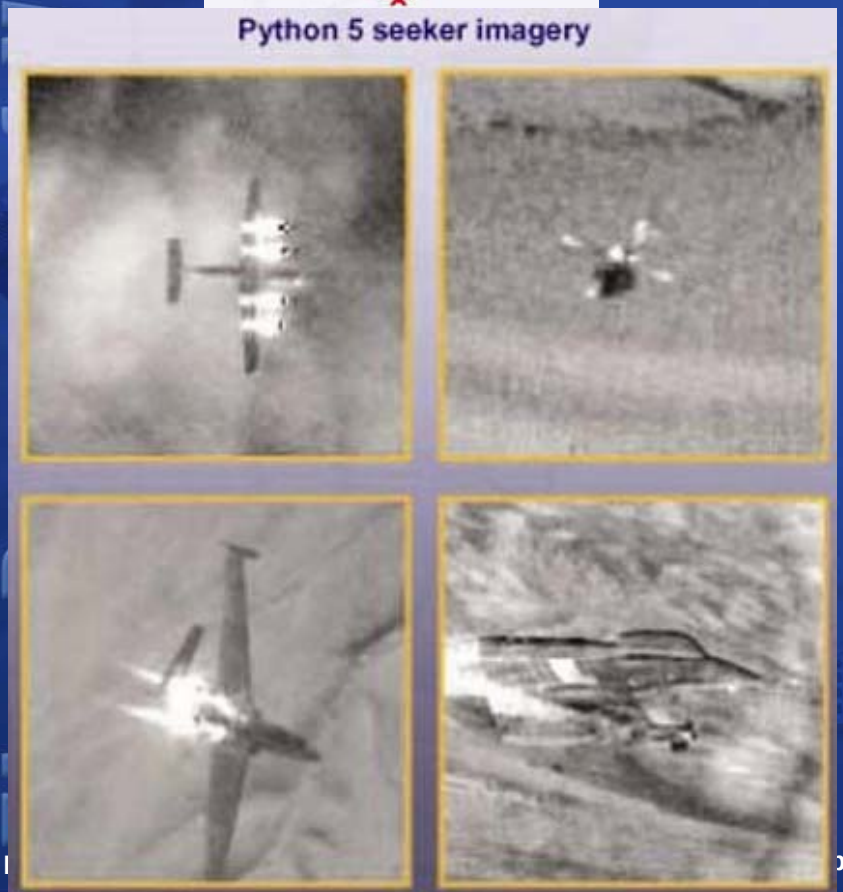
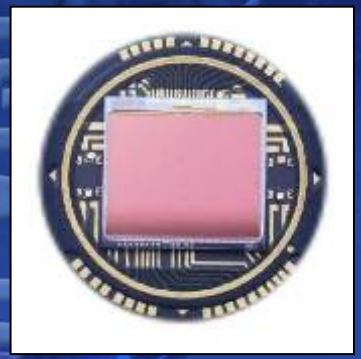
Rafael's Python 5





2000

320x256x30µm Blue fairy



Piccolo

Lion 2

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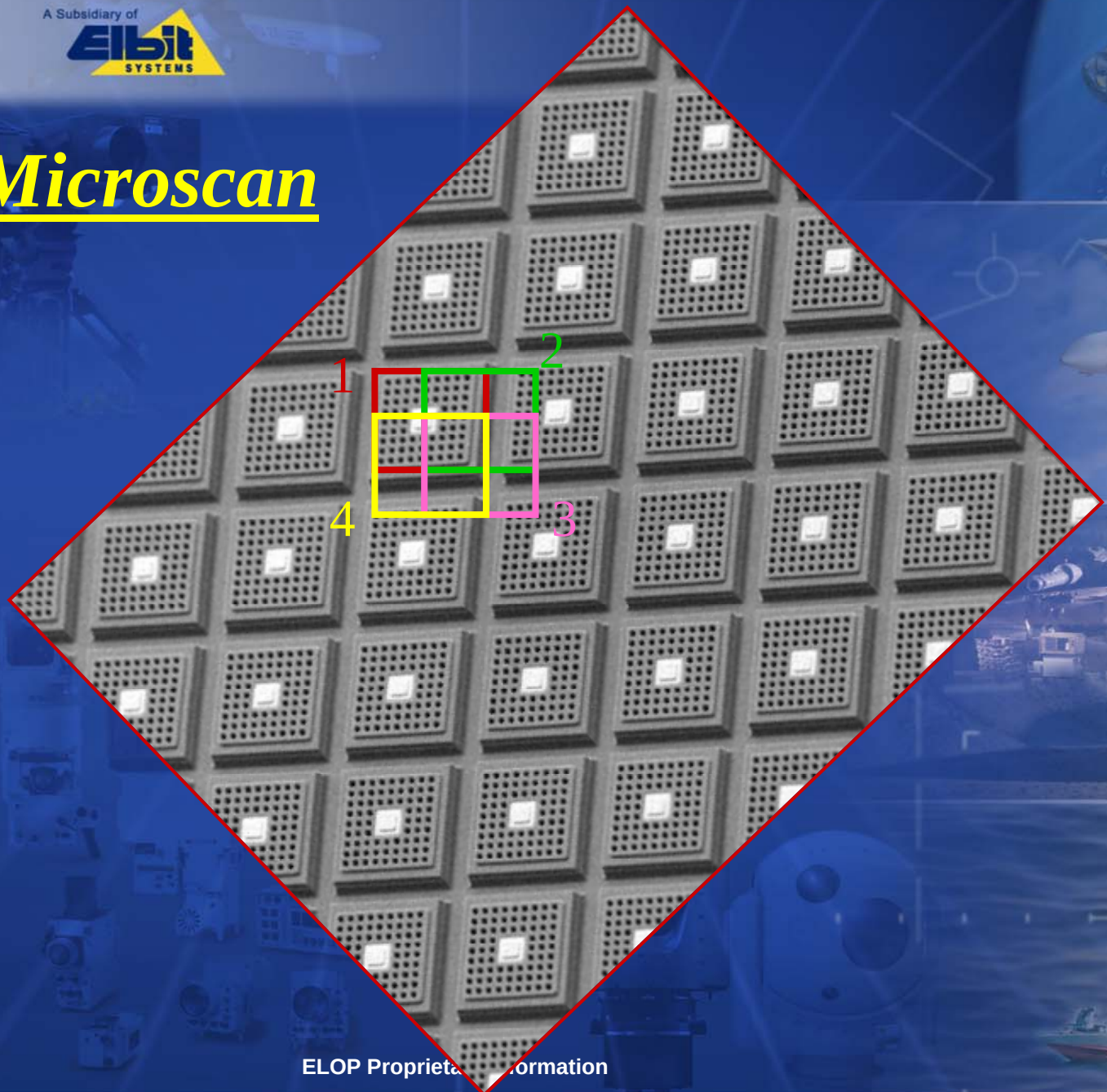
2D - Microscan



LORROS

AMPS - STABILIZED TURRET ASSEMBLY (Basic Configuration)

FLIR

V

Zoom Day Sensor in M/W FOV

Day Sensor in NFOV

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LITENING - Rafael

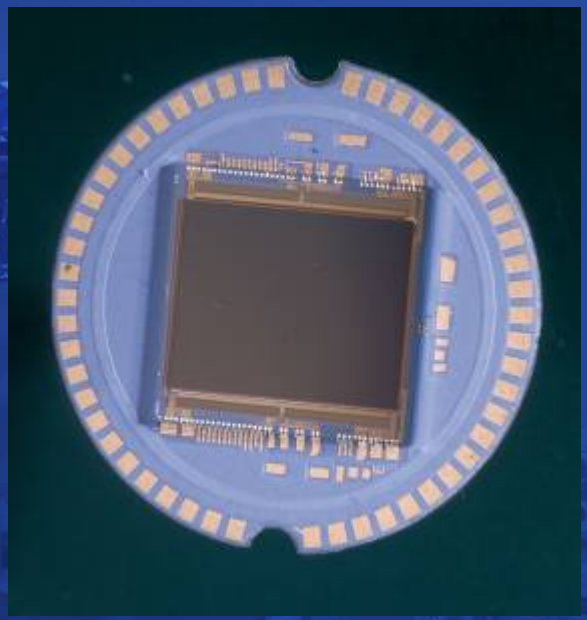
Targeting and Navigation Pod for Fixed-Wing Aircraft

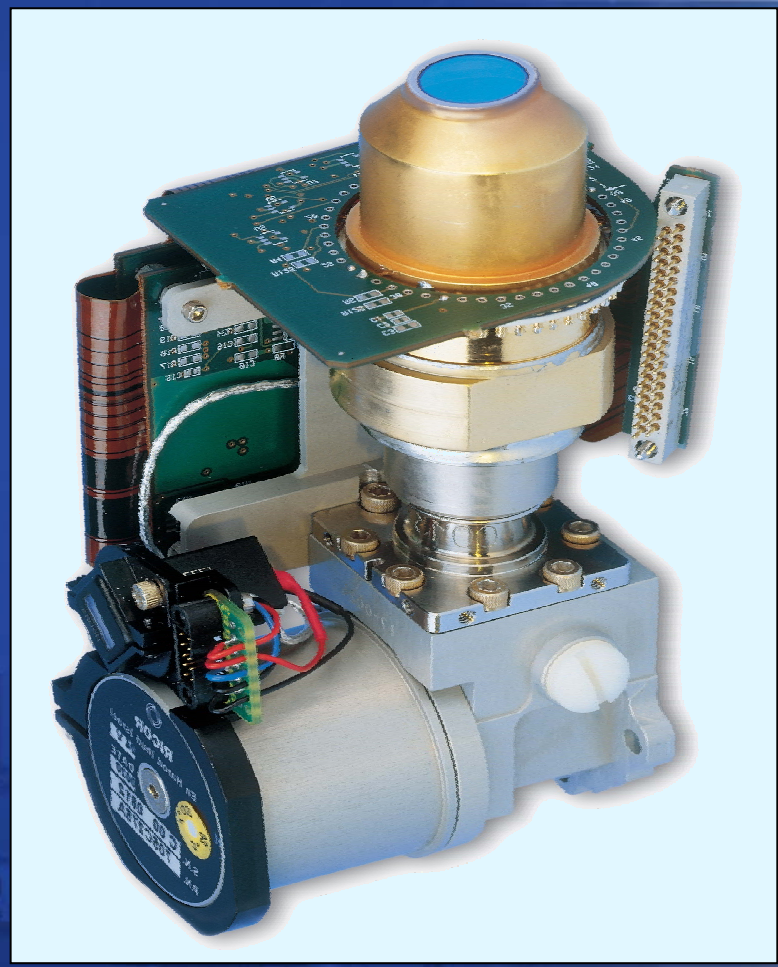
- High resolution 3-5 micron thermal imager
- Laser Designator & Rangefinder
- High-altitude Operation (40,000 ft)

Litening Pod

2003

Sebastian 640x512 20micron Pitch





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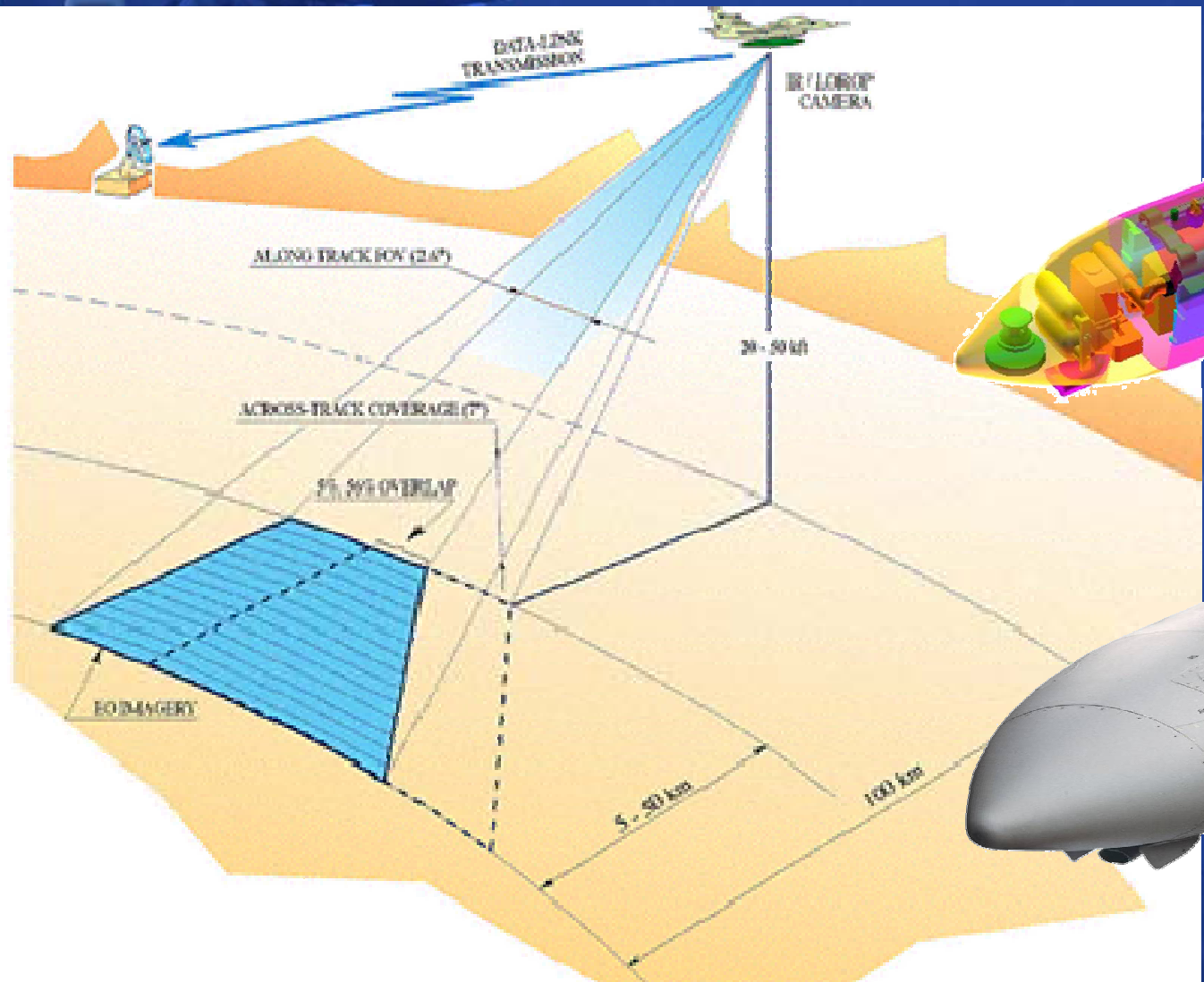
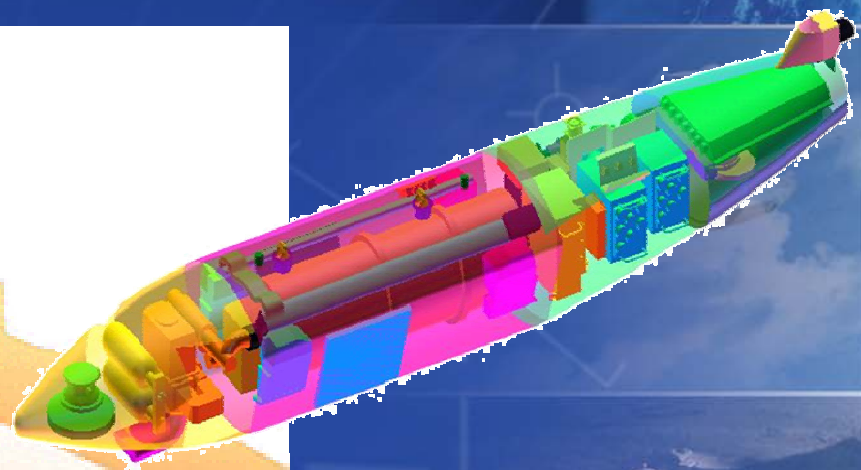
LOROP- Long Range Oblique Photography



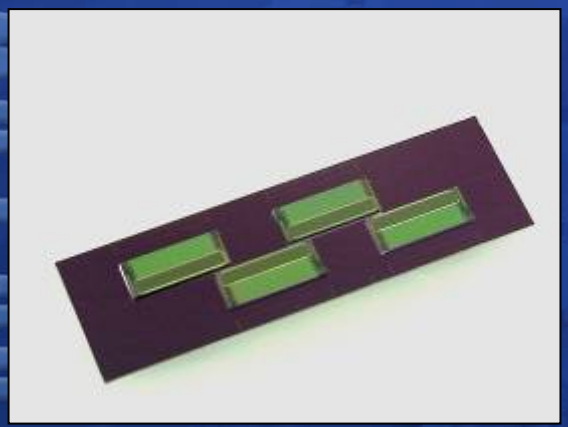


LOROP - Long Range Oblique Photography

LOROP- Long Range Oblique Photography

2002

(InSb 2048x? TDI)



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Uncooled Products

Made by El-Op with different detectors sources

No Israeli Source for Uncooled Detectors

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Israeli MOD oppose development of uncooled detectors

Establishment of an Israeli MOEMS consortium in January 2001through the ministry of trade and commerce

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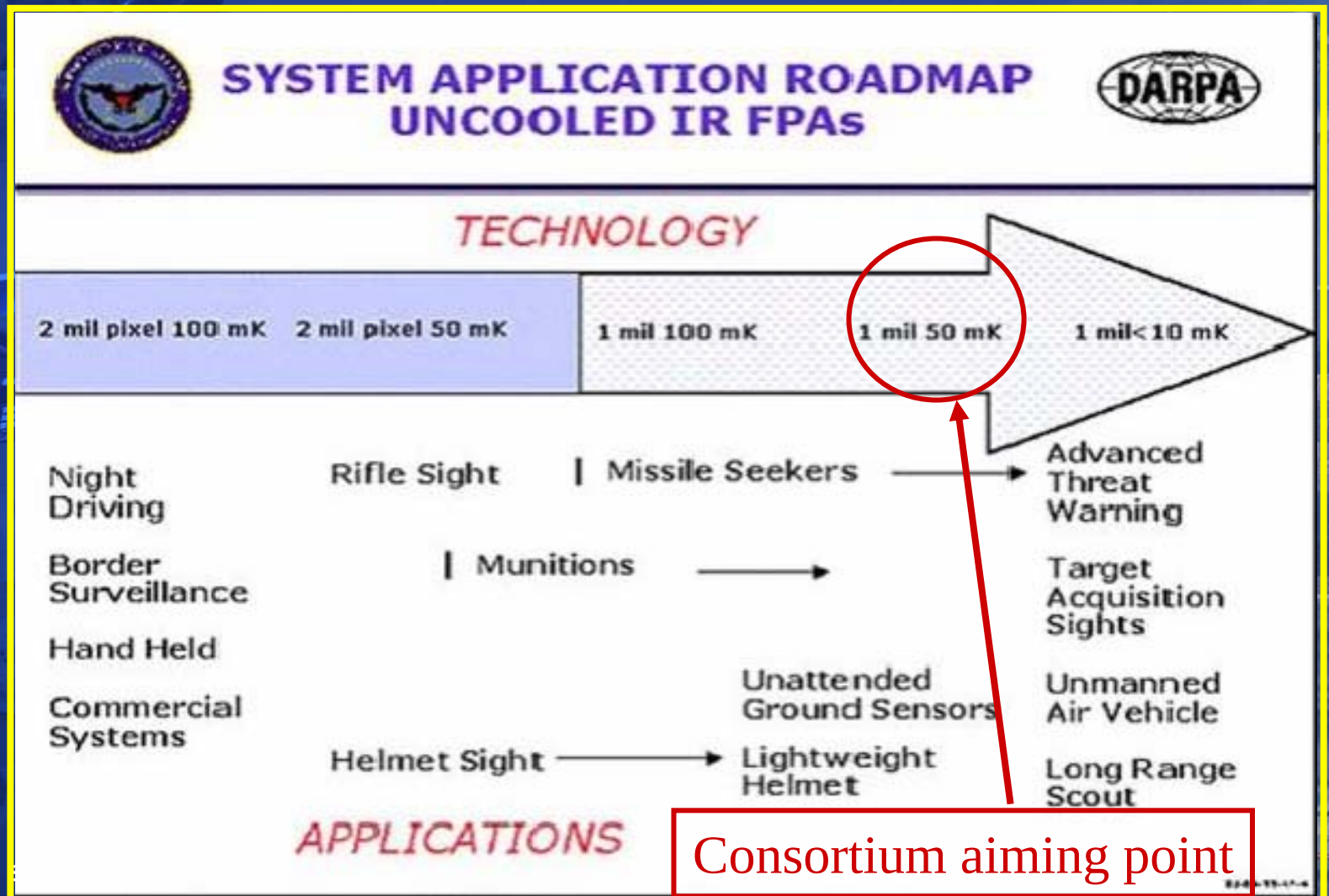
Uncooled Micro-bolometer IR detectors

(DARPA's road map)



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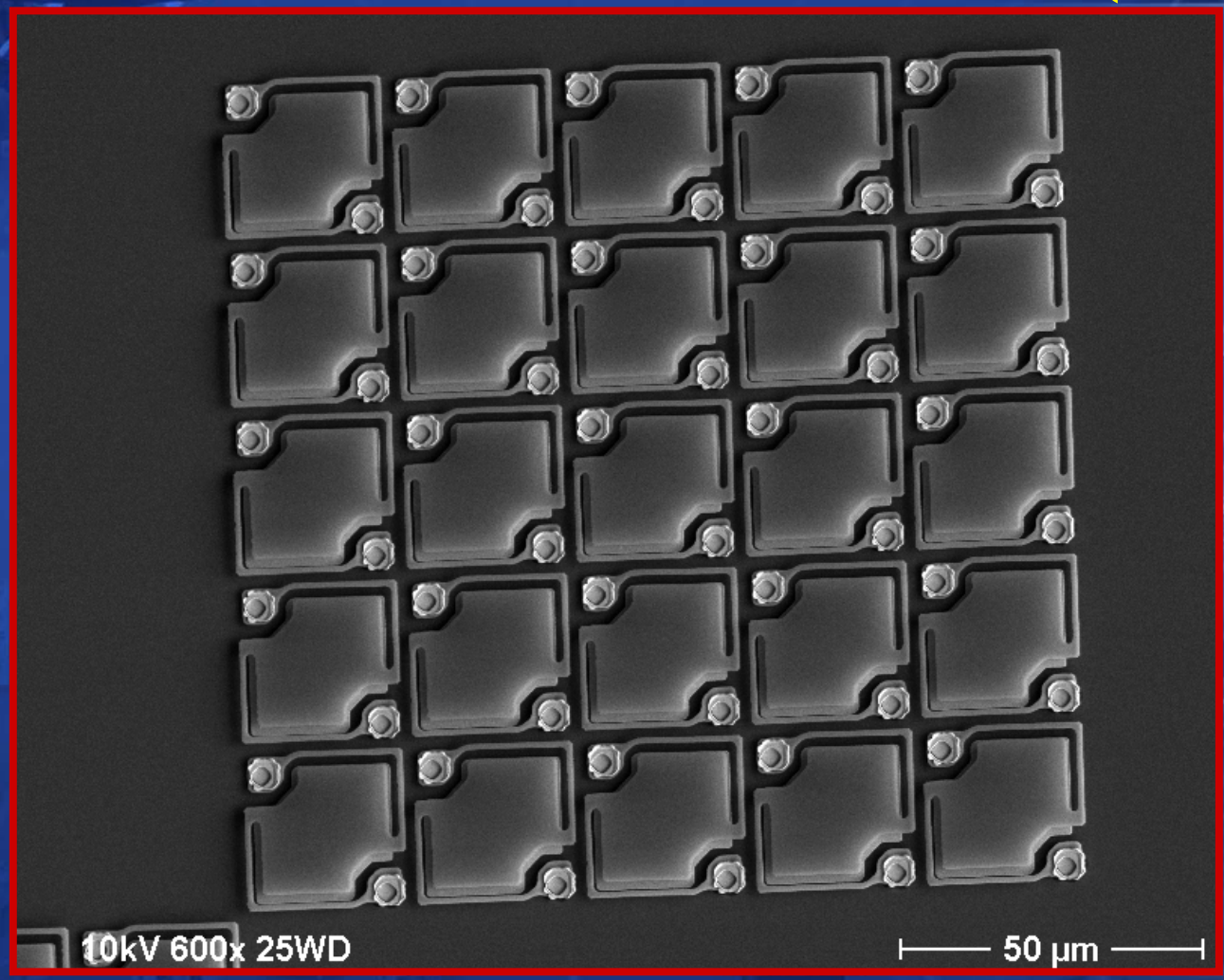
SCD's Uncooled IR Microbolometers (2003)



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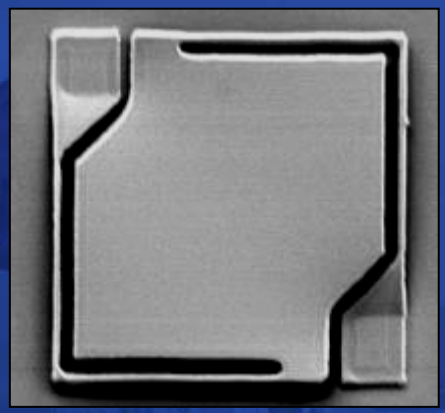
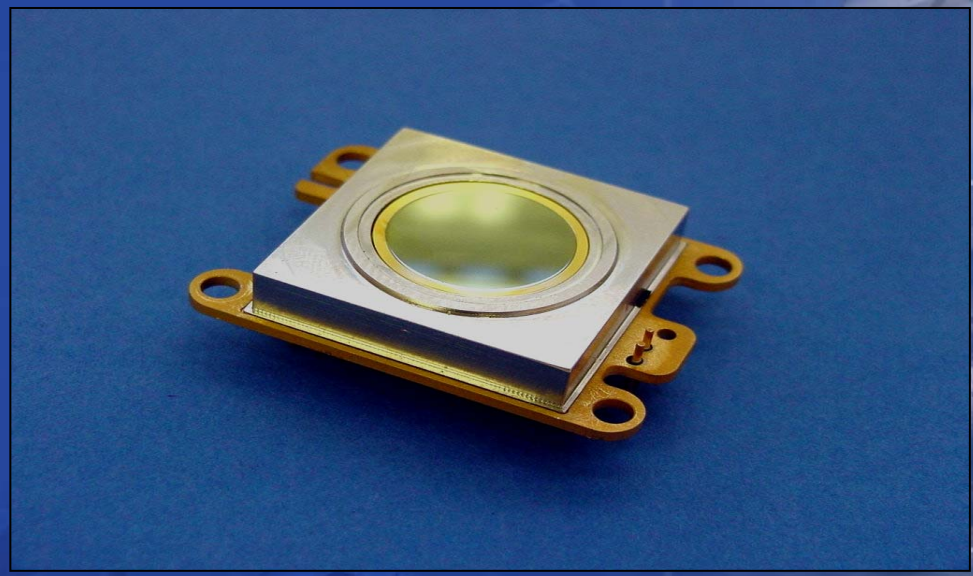
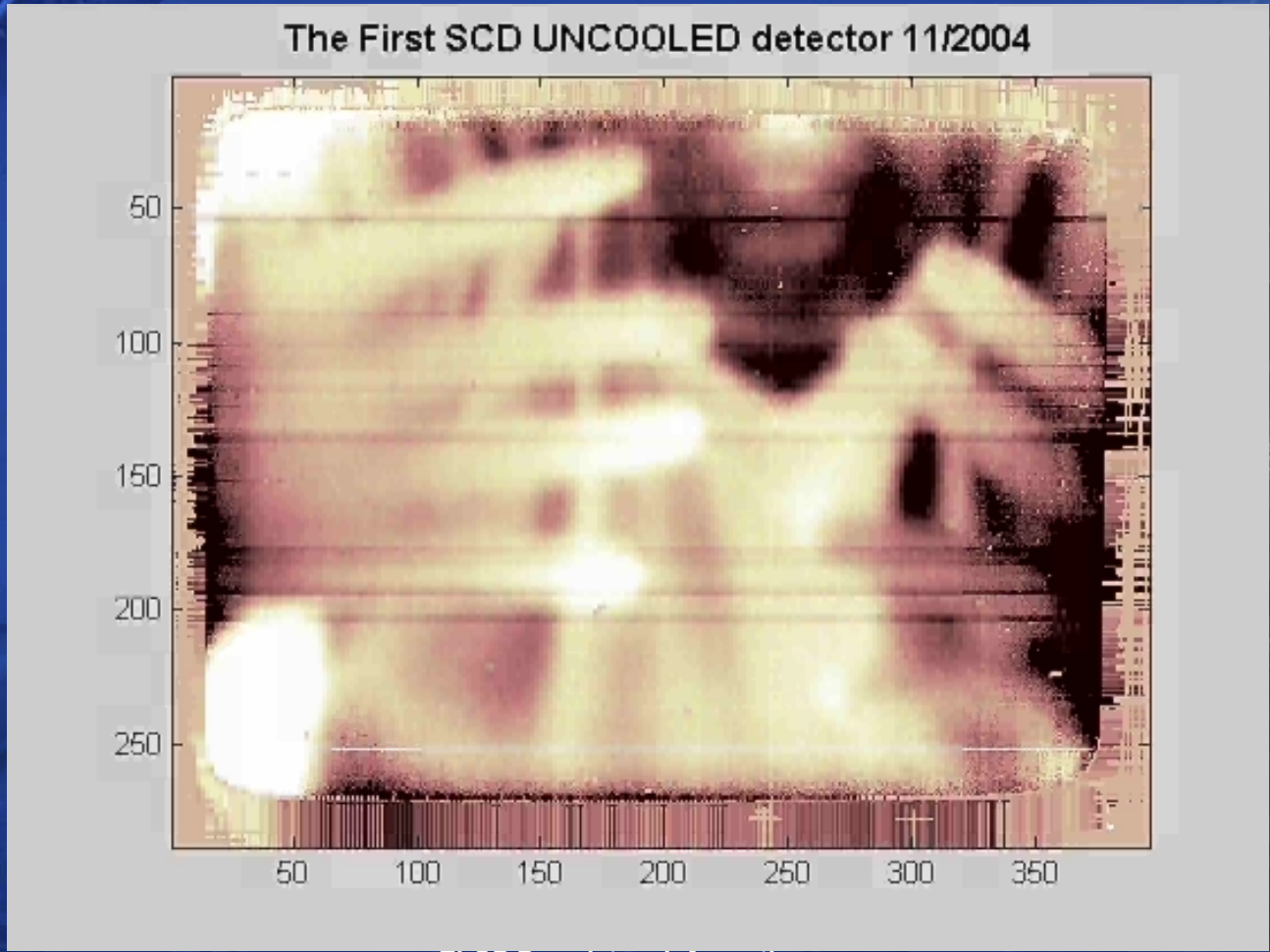
Uncooled VOx Bolometer 384x288x25µm made by SCD





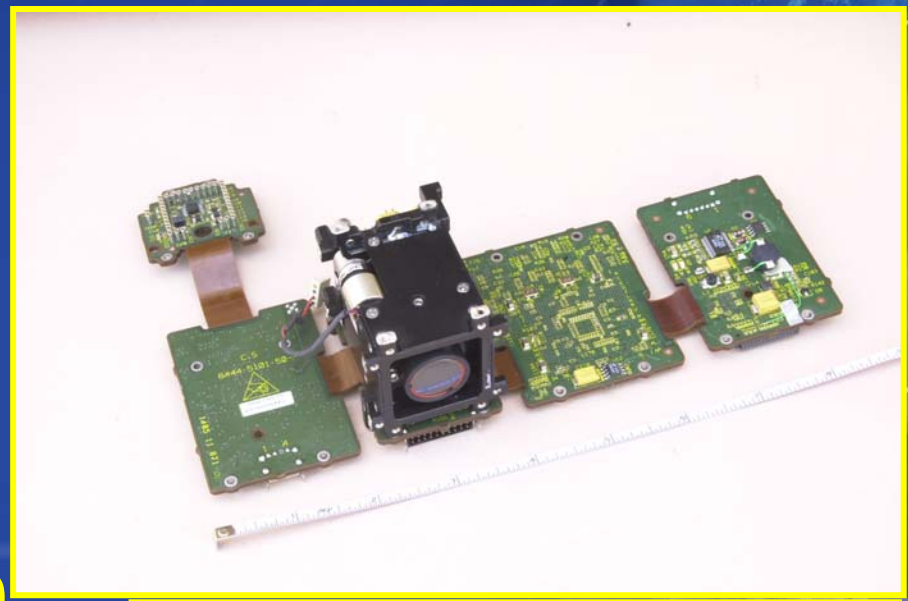
The Power of Vision

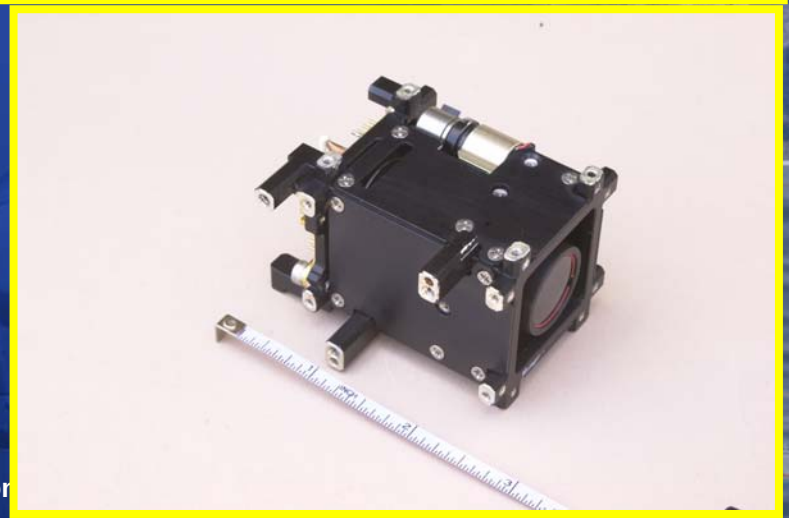
A piece of history: the first demo of VOx uncooled FPA at SCD –November 2004



El-Op's Uncooled Micro FLIR - Juniper

- Field of View 25°X19°
- f/# 1.6
- Dimensions 60x55x70 mm^3
- Weight < 250 gr
- Based on SCD microbolometer Detector
- Resolution 384x288 pixels
- Low noise (NETD < 50mk @ f/1)
- Advanced Image Processing Algorithms
- Human Target Recognition ~ 200m





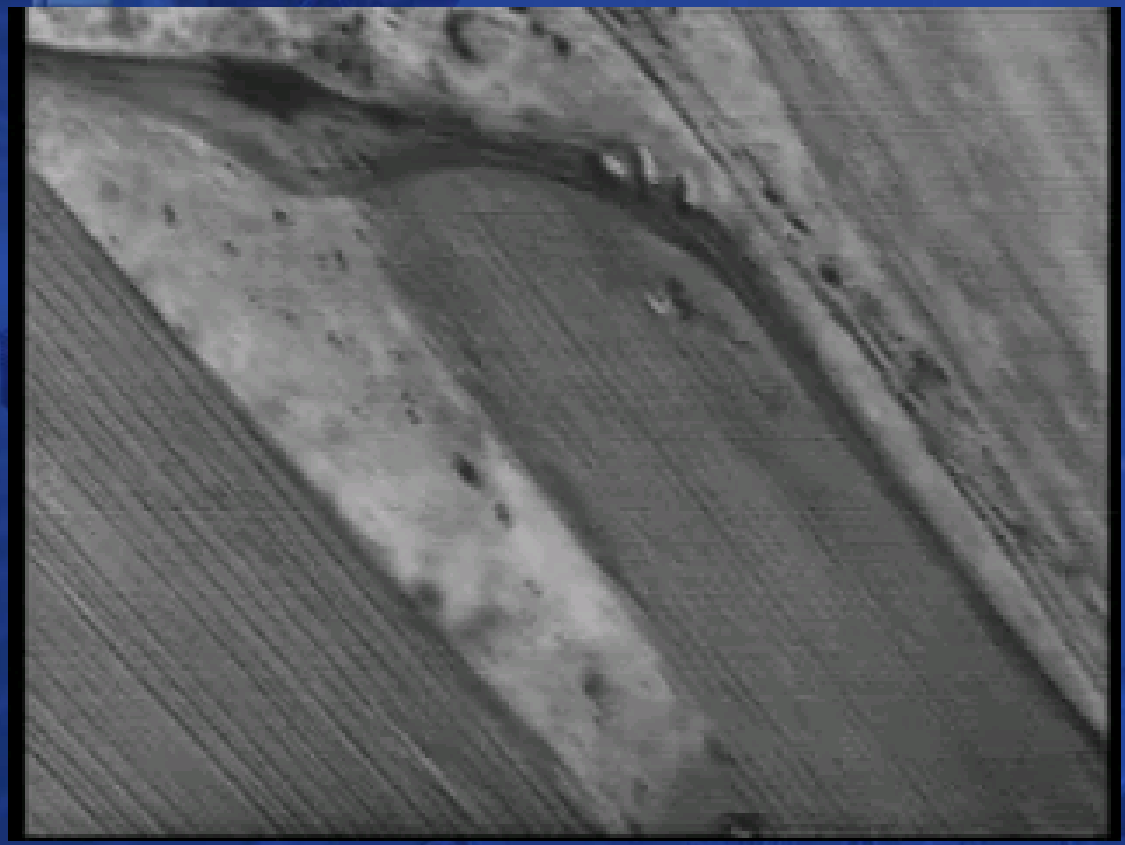
Elop's Juniper micro-UC FLIR for micro-payload ground tests

Integration to micro payload of the micro UAV

(Skylark – Elbit Systems)

- Day or night payload
- Single FOV at night 23 ° x17 °
- Nose mounted payload

The food chain of micro UAV uncooled IR camera

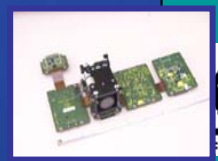


Micro UAV

Micro Payload

Micro Gyro

Micro FLIR



Micro bolometer

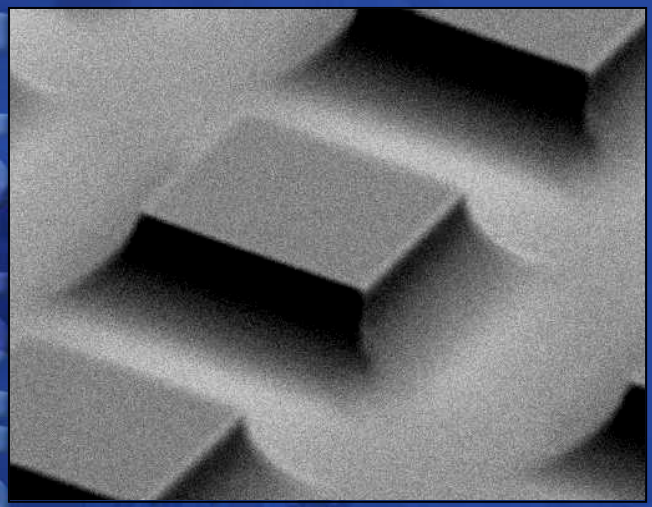
In Development for the Fourth Decade 2006-2116:

ABC

See spot QWIP

2005

ABCS

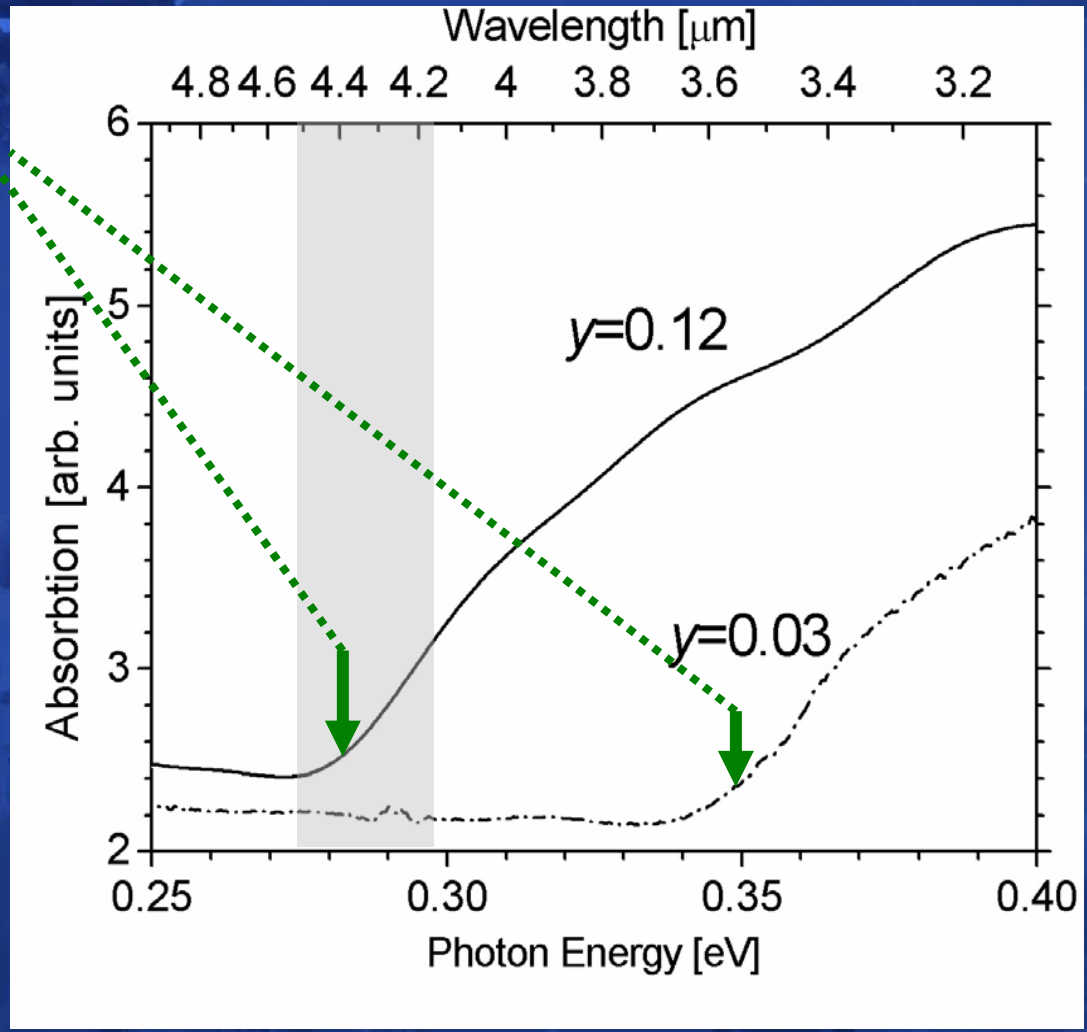


SCD

Optical Absorption Spectra

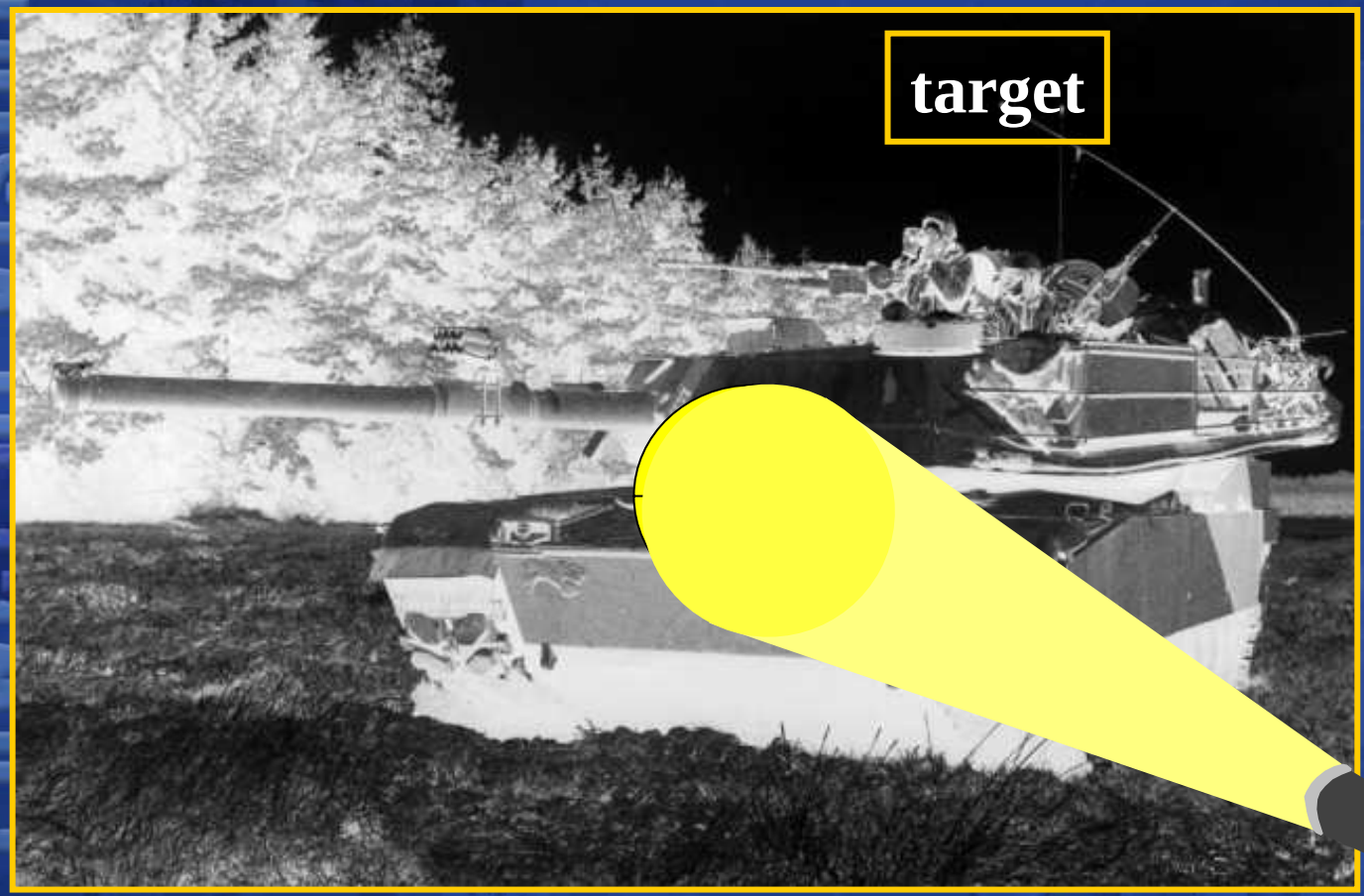
$InAs_{1-y}Sb_y$ ALLOYS on GaSb

Theoretical positions of edges



Laser See-Spot FLIR

(SWIR+LWIR for laser see spot and tracking)



How does it reflects the detectors technology?

ΔT → **Laser energy**

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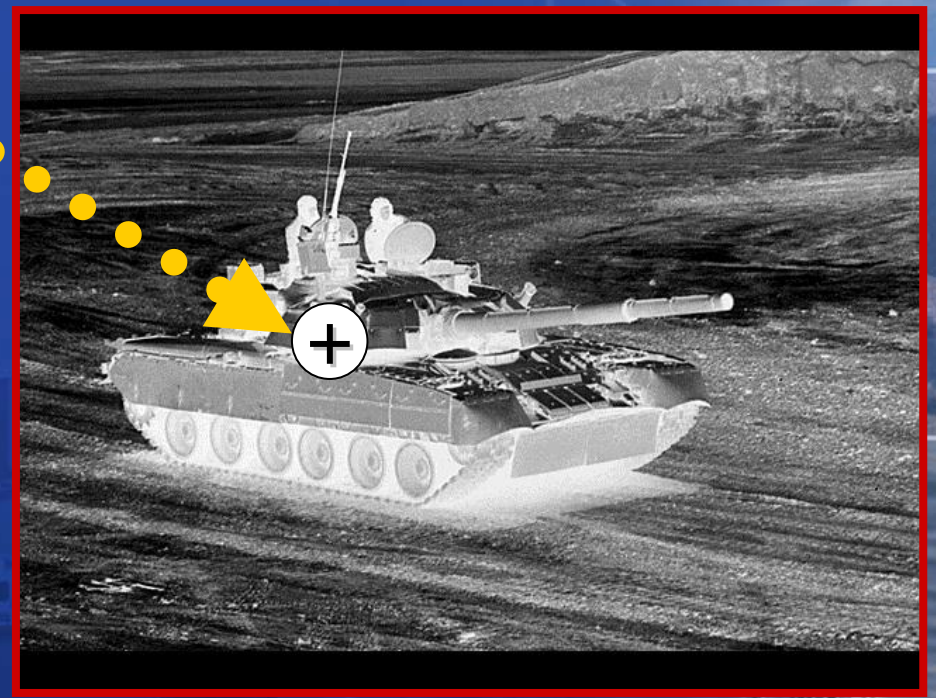
Designator and observer in one system

Designator & observer



Target

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The Power of Vision

Thank You

See you again in the next 30 years?!